

User-Centered Approach to the Design and Management of Operating Documents

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ABSTRACT

This paper presents the ongoing process and current results of a collaboration between NASA/FAA researchers and commercial aviation operators to restructure and update operating document guidelines and to develop a user interface for managing those documents. The paper first presents the background of this collaborative effort that started with a review of existing flight operating document guidelines. There are many guidelines covering most aspects of document development, but they can be difficult to access because they are distributed across different reports or hard to locate publications. To correct this situation, researchers and US operators have identified the most important document development topics and organized them in operationally meaningful ways. This paper outlines the user-centered approach taken to identify the key flight document issues and presents two applications based on the results: 1) a new structure for an operating document guidelines manual, and 2) a prototype user interface for a tool to manage the development and maintenance of documents.

Keywords

Operating documents, guidelines, standardization, user-centered design, user interface, information management, documents database

INTRODUCTION

The NASA/FAA Operating Documents project has evolved as an applied synthesis of two independent research efforts to integrate CRM principles into flightcrew procedures. These two research projects focused on enhancing crew performance through better designed procedures and their supporting documents. Aspects of procedure and operating document design and standardization were analyzed to identify areas of improvement. One of the projects identified the need to better address operational issues when designing new procedures and documentation [14].

Although many guidelines exist to advise most aspects of flight document development, they are difficult to access because they are distributed across different reports and other publications [e.g., 1,2,3,4,5,6,7,15]. To address this

situation, representatives from US operators have participated in a structured process to identify their most important document development topics and issues and to organize them in a way that is operationally meaningful.

Guidelines Manual

One of the two main products of this NASA/FAA project is the Developing Operating Documents Manual [10]. This manual includes guidelines and examples gathered from existing studies and from operators who have participated in a set of operating document workshops [12, 13]. Results from the workshops have been used to assess existing guidelines and reorganize them into a manual for operators. Further, the results have been used to develop a tool for managing the development and implementation of flight documents as an integrated information system.

At the project's inception, operators were concentrating on traditional paper documents and were starting to consider the use of electronic or digital information systems. Electronic data was being considered in flight operations, specifically databases and tagging to manage document systems. On the flight deck, stand alone and integrated electronic flight documentation were being evaluated. Whether in flight operations or on the flight deck, the move to digital data brings with it the challenges and dangers of information overload and nonfunctional design [11]. Digital data display removes many constraints such as the physical page that bounds the traditional manual along with the weight and size limits inherent in existing operating documents. The removal of these constraints can launch designers into a new environment with a profusion of information and interface options [11]. Thus, the transition to electronic media became a growing part of the guideline effort which started at a time when that medium was not widely used to manage and display flight deck documentation.

Operating Documents Database

The second product of this project has been the specification and development of a user interface for a Documents Database (DDB). The DDB is a structured listing of information topics, requirements, sources, users, and related data essential to operators in the management of a flight documents system. A DDB should be designed

so that it may be linked with other operational databases that contain policy, procedure, and crew training information.

The DDB concept grew out of the realization that a database would help manage the large amount of information and documents required to support flight operations. A DDB should be tailored to meet the operator's individual needs while adhering to standards that would allow linking to other operational and training databases.

DDB development should include the identification of information units or topics needed to be addressed by the information system. Some topics should be specified at a relatively high level and others specified at lower levels because they require decomposition for easier management. For example, some topics may have several different users and may also need to be presented in more than one context suggesting the need for greater decomposition. Operators should review their own document system or those of others with similar operations in order to identify topics and help determine their appropriate level of detail. Operators should use an iterative process by starting with relatively high-level topics or units of information that may be further divided as operational needs dictate. Both topic identification and the DDB interface should have sufficient flexibility so that they can be easily updated and reorganized.

A major challenge in the development of a DDB is ensuring that essential information is included without making the database so large or complex that it cannot be easily used or maintained. In order to achieve this balance between completeness and maintainability, the NASA/FAA Operating Documents project has worked with operators to identify their information management needs. Manufacturers provide specific information on their products (aircraft, engines, individual systems, etc.) in flight manuals, operating manuals and training manuals that can be used as a first step to ensure a comprehensive DDB. When manufacturers and operators agree on a data exchange format, operators may achieve some level of automatic DDB update when manufacturer data is translated into specific operator information.

The DDB should be developed and used as early as possible in the design of an operating document system. Once developed, the DDB can be used to manage the operating documents implementation process to include the tracking and distribution of document revisions. In addition, the operator may include notes about design and implementation issues and difficulties that need to be addressed during document system changes or future revisions. By maintaining a history of these issues, operators can capitalize on lessons learned and avoid repeating mistakes that may have been made at an earlier point in time.

APPROACH

Through workshop and focus group participation, user-centered methods were employed to identify operating

document user requirements. A diverse sample of those in charge of designing, developing, and managing document systems grew to about 100 individuals from more than 20 organizations representing a cross section of major, regional and cargo operations, the FAA and aircraft manufacturers. The user-centered approach included:

Part One. Requirements identification for the manual and the user interface

- Identify categories of topics
- Identify operating document topics
- Prioritization of topics

Part Two. Focus group review and usability testing

- Review manual contents and database displays
- Rapid prototyping
- Prototype usability testing

Requirements Identification

For Part One, a series of surveys was administered in order to identify the topics and categories of document development issues of highest importance to operators. From this effort resulted a form with a total of 62 topics divided into nine categories such as Overall Organization of Documents and Standardization. Prioritization of topics was then determined by administering this form to documentation experts at the end of a two-day workshop where each operator had presented their key operating document issues. Some of these results are described later and depicted in Table 1.

Methods used to analyze ratings, such as those collected on the survey form, are not always systematic or repeatable. One limitation of these methods has been the lack of inter rater agreement. Without this type of reliability control, one may obtain different interpretations of the results by including unreliable scores. One set of inter-rater reliability tools have been developed and implemented in flight operations that provide an efficient way to assess rater agreement, consistency, and congruency [8]. This project used the Agreement Index (AI) to help focus on those results with a substantial degree of rater agreement.

AI is computed to determine whether the group has reached consensus regarding the rating of specific issues. The Agreement Index, as its name implies, does not establish reliability, rather, it indicates agreement among rates. AI represents the degree to which a single group of judges or subject matter experts give similar ratings for the same item based on a statistic, r_{wg} [9]. With AI, 1.0 represents perfect agreement and 0 would indicate no agreement.

Focus Group Review and Usability Testing

Part Two, group review and usability testing, consisted of focus group reviews of individual parts of the manual culminating in a large group review in which a draft of the manual was presented and reviewed in its entirety. The

Table 1: High Priority Topic* Ratings by Operator Type (n = 24)

*High Priority Topics are those rated with a MEAN • 4 (on a 5-point scale where 5=Highest Importance) and with an Agreement Index (AI) • .6 (MEAN and AI emphasized by shading and bolding)

CATEGORIES & Topics	Major Operators		Regional Operators		Cargo Operators	
OVERALL ORGANIZATION OF DOCUMENTS	MEAN	AI	MEAN	AI	MEAN	AI
Cockpit-based vs. flight bag vs. at home	2.89	0.62	3.14	0.51	4.25	0.91
Consolidation of checklists	3.11	0.51	4.00	0.71	3.25	-0.09
Index across documents (system index)	4.22	0.58	4.29	0.76	3.00	-0.25
Merging/consolidation of manuals	4.00	0.67	4.00	0.43	3.25	-0.59
Reducing number of documents	4.44	0.77	4.14	0.65	4.25	0.66
Redundant information issues	3.78	0.58	4.14	0.80	3.75	-0.34
Reorganizing documents	3.67	0.67	4.57	0.73	3.00	0.25
PHILOSOPHY & POLICIES	MEAN	AI	MEAN	AI	MEAN	AI
CRM procedures & policy	4.22	0.80	4.00	0.86	3.50	0.88
Flow-driven procedures & checklists	4.22	0.58	4.14	0.51	4.00	0.75
Manual revision policy	3.78	0.69	4.00	0.71	4.25	0.91
STANDARDIZATION	MEAN	AI	MEAN	AI	MEAN	AI
Standardization across documents	3.78	0.36	4.29	0.90	4.25	0.66
Standardization across fleets	4.33	0.22	3.71	-0.10	4.50	0.63
Standardization of terminology	3.89	0.51	4.43	0.88	4.50	0.63
Standardized flows	4.22	0.80	3.57	0.31	3.75	0.16
DOCUMENT DEVELOPMENT PROCESS	MEAN	AI	MEAN	AI	MEAN	AI
Integration of vendor documents	3.11	0.84	3.71	0.47	4.00	0.75
Integration with Regulations & Manufacturers	3.78	0.80	4.00	0.71	3.50	0.38
Involvement of POI's	3.89	0.95	4.14	0.80	4.25	0.66
Revision and updating document content	3.44	0.88	4.29	0.76	3.50	0.38
Training of new procedures	4.11	0.73	4.00	0.86	3.75	0.41
DOCUMENT USABILITY & INDEXING	MEAN	AI	MEAN	AI	MEAN	AI
Human factors of checklist design & format	4.22	0.80	4.71	0.90	4.50	0.88
Managing the accomplishment of checklists	3.78	0.25	4.43	0.73	3.50	0.88
Memory Items / Immediate action items	3.44	0.21	4.57	0.88	4.00	1.00
Navigating from one checklist to another	3.89	0.73	4.14	0.80	3.75	0.41
Navigating within documents	4.22	0.58	4.00	0.86	3.25	0.41
Navigating within procedure	4.00	0.78	3.57	0.59	3.25	0.41
Techniques vs. procedures	3.89	0.62	4.14	0.94	3.00	0.75
TRANSITION TO ELECTRONIC MEDIA	MEAN	AI	MEAN	AI	MEAN	AI
Design guidelines for electronic documentation	4.11	0.40	3.86	0.51	4.00	0.75
Integrate electronic media with FAA standards	3.89	0.84	4.00	0.57	4.50	0.63
Onboard computer systems	3.44	0.10	2.43	0.02	4.50	0.63
Use of intra/internet	3.89	0.51	3.00	0.43	4.50	0.88

manual content, structure, and key issues were also used to design the information management tool. Initial development of the DDB started with the identification of specific content, but it soon became evident that a better approach would be to conduct usability testing. A prototype DDB user interface was developed, reviewed, and then tested by a set of operators who entered information topics and provided user feedback.

RESULTS

This section details the topic rating data used to direct manual development and the initial DDB user interface design. The rating results shown in Table 1, based on 24 participants from a two-day workshop [12], indicate the highest priority topics, those with a Mean greater or equal to 4.0, and an Agreement Index greater or equal to .6. These are the 30 topics, out of the 62, rated as highest priority by one or more type of operator.

These ratings underscore the differences in priorities among three types of operators: 1) Major Operators, 2) Regional Operators, and 3) Cargo Operators. Comparing across operator type, there is agreement among all three operator types on a few topics (e.g., Reducing number of documents) and there are more differences in focus. Major operators tended to focus on just one or two topics per category. Regionals, on the other hand, found many topics to be highly important within most categories with the greatest number of high priority topics under Overall Organization. Cargo operators placed great importance on topics related to Transition to Electronic Media. These ratings indicate variations in interests and concerns due to operational, organizational, and economic differences.

APPLICATION

The resulting operating documents topics and issues were used to organize the guidelines manual and to develop the initial design for the DDB user interface.

Guidelines Manual

The operating document topics and issues were used to structure the guidelines manual so that operators could easily access the needed guidance as they worked through the planning, design, and management process. The outline of the manual is shown in Table 2 starting with the planning phase (i.e., Part 1), and ending with Part 4, Transition to Electronic Documents.

The outline is organized in the way operators approach the development of documents starting with planning phase (Part 1) which covers issues related to the organization of the entire operating documents system. The sections under Part 1 deal with topics of consolidating, managing redundancy, and reducing the number of documents, the high priority topics listed in Table 1. Relevant guidelines and examples are included in each subsection. Part 2 of the manual covers the design of individual documents to include topics of standardization and usability. Part 3 addresses the document production and maintenance processes. Finally, issues and guidelines related to electronic media are presented in Part 4, Transition to Electronic Documents. The new structure of this manual takes guidelines that were organized under research topics and presents them in sections that follow operators' information system development and management processes.

Table 2: Outline of Developing Operating Documents Manual Showing Parts and Sections

PART 1 - ORGANIZATION OF DOCUMENTS
1.1 Organizing System
1.2 Required Information
1.3 Additional Information
1.4 Creating an Information System
1.5 Reviewing and Testing the System
PART 2 - DESIGN OF DOCUMENTS
2.1 Incorporating Regulations and Manufacturer Recommendations
2.2 Standardization
2.3 Optimizing Procedures
2.4 Usability of Checklists
2.5 Usability of Documents
PART 3 - PRODUCTION AND MAINTENANCE OF DOCUMENTS
3.1 Introduction of New Procedures and Information
3.2 Internal and External Approval Process
3.3 Production Process
3.4 Revision, Distribution and Tracking
PART 4 - TRANSITION TO ELECTRONIC DOCUMENTS
4.1 General Considerations
4.2 Regulatory Standards
4.3 Considerations for Electronic Document and Display Systems
4.4 Planning for Internet/Intranet
4.5 Cost/Benefits of Electronic Media

DDB User Interface Rev. 1.2

Information Requirements

Information Topic

Information Requirement

Information Source

Information Responsibility (OPR)

Operating Document

Regulatory Approval

Information Organization

Information Type

Information Location

Information Users

Information Importance

Information Maintenance

Information Distribution

Revision

Last Revision

Information Date

Information Descriptors

Phase of Flight

Envrnmntl Factors

Crew Qual

Systems

Policy

Training

Mngmnt Structure

Com Interface

Procedures

Figure 1: Representation of the Prototype DDB User Interface (Revision 1.2)

DDB User Interface

The results were also employed in developing the user interface for an information management tool. The need for the tool was based in part on the fact that both major and regional operators had the most high priority topics under the Overall Organization of Documents category.

Operators were just beginning to look at their operating documents as an entire system rather than as a collection of manuals, cards, and guides. One operator in particular, who was in the process of a complete restructuring of the system, expressed a strong need for a management tool. The guidelines manual was being designed to help in the

development and implementation of documents, and the DDB interface was designed to help manage flight operations information.

The current structure of the DDB user interface is shown in Figure 1 representing functions that are accessed from top to bottom. The top two sections of the interface, Information Requirements and Information Organization, are used to manage the overall content and structure. The third user interface section, Information Maintenance, facilitates the ongoing maintenance of information. Finally, the Information Descriptors are used to manage data central to the design of operating documents.

CONCLUSION

The NASA/FAA Operating Documents project was formed to identify key issues in the development of operating documents, and has resulted in a guidelines manual to help operators address those issues, and a prototype DDB user interface to manage flight information systems. Operators have specific needs when developing document system, and they are particularly interested in the best way to organize, present, and manage information required for flight, with an emphasis on time critical elements.

The initial emphasis on traditional paper document development grew to include a broader view of the document system, an appreciation of issues related to the transfer to electronic documents, and a need for an information management tool. This expanded emphasis was due to operator input collected via a user-centered design approach. At every step of the way, user feedback in the form of survey, ratings, testing, and comments, was collected and analyzed to determine the high priority issues across this diverse user population.

This effort has resulted in the Operating Documents Manual that addresses the most important operator issues and provides current examples of different approaches. It has also produced a prototype DDB user interface to help operators manage flight documents. This collaborative effort between researchers and operators has helped to move the aviation community from a focus on individual documents to an emphasis on the entire flight information system.

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